

REDUCING HAND-ARM VIBRATION THROUGH USE OF BETTER PROTECTIVE EQUIPMENT AND LOW-VIBRATION POWER HAND TOOLS

The Navy Clothing and Textile Research Facility supported an evaluation by the National Institutes for Occupational Safety and Health (NIOSH), to identify commercially available anti-vibration (AV) gloves and to measure their effectiveness at reducing exposure to vibration commonly generated by powered hand-tools. The study determined the most effective gloves for reducing exposure to various frequencies of vibration and found that several gloves marketed as having vibration-reducing qualities were not highly effective. Study results were communicated to the General Services Administration and Defense Logistics Agency to ensure that only the most effective products are marketed by the Federal Government. The research project also developed guidance for a simpler and more efficient way of evaluating the effectiveness of gloves used to reduce transmitted hand-arm vibration. This project was part of a larger collaboration between DOD, GSA, DLA and NIOSH to improve the availability of low vibration power hand tools and certified (third-party tested) anti-vibration gloves within the Federal supply system and increase awareness of hand-arm vibration issues and control measures



A team including DOD, General Services Administration, NIOSH and contractor support experts met at the NIOSH facility in Morgantown, West Virginia to develop procurement criteria for low vibration power hand tools and anti-vibration gloves in February 2008 as part of a project supported by the DOD Defense Safety Oversight Council (DSOC).

Introduction

Upper extremity ergonomic injuries are among the major musculoskeletal disorders at workplaces where exposures to hand-arm vibration occur. Overexposure to vibration, such as from use of powered hand-tools, can cause a disabling, irreversible, and incurable occupational disease known as Hand-Arm Vibration Syndrome (HAVS) which results in nerve and blood vessel destruction in the hands, arms and fingers. Severe cases of this disease, among non-Navy personnel are illustrated on the following page:



Hands of vibrating pneumatic hand-tool operator in later stages of irreversible Hand Arm Vibration Syndrome1



Rare case of gangrene in hands of vibrating pneumatic hand-tool operator at terminal stage of irreversible Hand Arm Vibration Syndrome2

Severe cases of Hand-Arm Vibration Syndrome (HAVS) disease, among non-Navy personnel are illustrated.

Symptoms of overexposure include:

- Pins and needles feeling, tingling, and/or numbness in fingers and hands
- Loss of finger sensation and dexterity (initially transient/temporary, but potentially more prolonged or permanent)
- Awakening at night due to pain in fingers and hands
- One or more fingers turn white ("blanch"), especially during cold weather

Powered hand tools that expose personnel to potentially harmful levels of vibration include, but are not limited to, shipyard construction and repair work, and aircraft maintenance and repair involving:

- Chipping hammers, grinders and various hand tools for surface preparation and finishing
- Pneumatic needle guns and other pneumatic tools
- Rivet guns, drills, bucking bars and nut runners
- Vibrating knives, jack-hammers and other demolition tools
- Chain saws and concrete saws



Selection of low vibration tools can influence maintenance and repair costs while preventing Hand Arm Vibration Syndrome.



Full finger, Anti-Vibration gloves reduce HAV exposure.

Most Navy personnel involved with extensive, prolonged use of power hand tools receive medical surveillance and/or qualification examinations for other potential work-place stressors such as noise, respirator use, and potential exposure to heavy metals. Those experiencing symptoms of concern should report/discuss them with medical personnel, ideally during routine physical/ occupational health examinations. Guidance for medical evaluation of vibration exposures are provided in the DOD medical surveillance matrix (number 508).

This success story summarizes achievements in the Navy, DOD, GSA, and NIOSH partnership to reduce exposure to HAVS in Navy and DOD personnel.

Navy shore installations and shipyards, along with leadership from the Naval Safety Center Liaison Office, organized and implemented a process for reducing the risk of HAVs. This work complemented a project sponsored by the Defense Safety Oversight Council's (DSOC) Acquisition and Technology Task Force. Additionally, a Navy-sponsored collaborative study between NIOSH Health Effects Research Lab in Morgantown, WV and the Navy Clothing and Textile Research Institute in Natick, MA demonstrated an increased grip effort due to anti-vibration gloves on a task requiring repeated forceful grip action which could cause more adverse effects than the benefit of the glove's vibration reduction. Recommendations provided by one aspect of the Navy Working Group's efforts with NIOSH provided the framework for helping to reduce vibration-induced disease.

Successes included:

- Development and distribution of an update to the 1980s NIOSH video on hand-arm vibration. This product is available through the Defense Media Agenda to both Federal and non-government entities at nominal costs.*

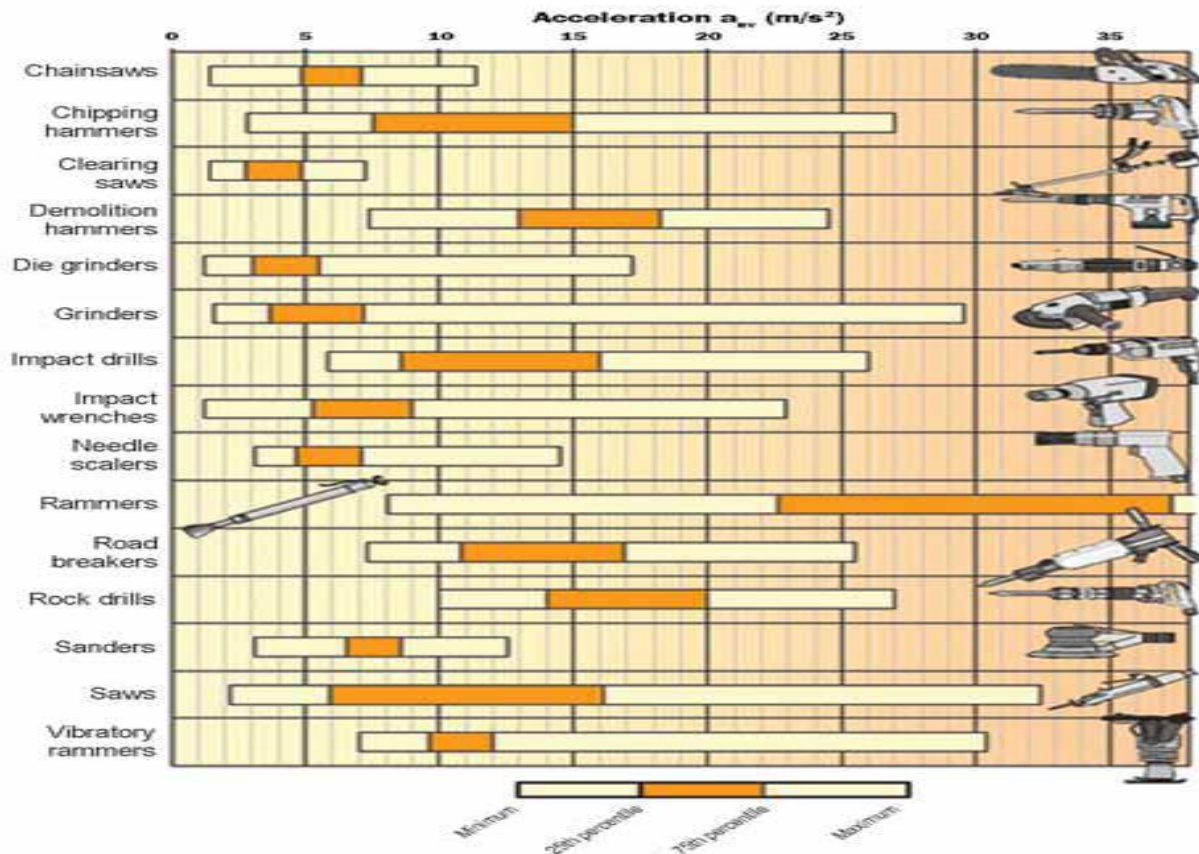
<http://defenseimagery.mil/imagery.html>.

*(The CD, *Hand-arm Vibration, Revisited* can be located by the identification or PIN number, **807012**).

- Made occupational health and safety professionals and management personnel more cognizant of how to recognize and prevent HAVS.
- Improvement of the process for selecting low vibration powered hand tools, including simplified guidelines for selection and procurement of better tools and certified anti-vibration gloves.

http://www.public.navy.mil/navsafecen/Documents/acquisition/Order_LowVib_tools.pdf

Tool selection and proper use is perhaps the most critical measure to prevent exposures to excessive levels of vibration. The General Services Administration is collaborating with the DOD Ergonomics Working Group to influence procurement criteria for power hand tools and make the best suitable products available to Federal users.



The above diagram illustrates the typical vibration levels associated with various types and models of power hand tools. (Taken from the European Union Guide to Good Practice on Hand-Arm Vibration, <http://www.humanvibration.com/EU/VIBGUIDE/HAV%20Good%20practice%20Guide%20V7.7%20English%20260506.pdf>)

A Study of Anti-Vibration Gloves

One available method of reducing the risk of HAVs to workers who operate the types of tools and machinery described above is through the use of Anti-Vibration Gloves.

Gloves may be advertised as “anti-vibration” (AV) without demonstrating a specific level of vibration attenuation because of the lack of regulatory criteria. In fact, there are several models of gloves which are marketed as “AV” gloves but which do not meet the requirements of the applicable American National Standards Institute/International Organization for Standardization (ANSI/ISO) standards for anti-vibration gloves. ANSI S2.73/ISO 10819, which is advisory in the US, specifies that anti-vibration gloves must provide full finger protection and provide a specific level of vibration reduction, measured at specified test frequencies by an independent laboratory. The Naval Safety Center Safety Liaison Office initiated a collaborative review of glove products described by their manufactures as “anti-vibration gloves” and “low vibration” hand-tools with many different subject matter experts including researchers from NIOSH.

Some Products Marketed as Anti-Vibration Gloves

Examples of certified products
Tested by in independent lab



Superior Glove Model VIBGHFV Half finger glove, Vibration protection in palm and base of fingers and thumb,



Remember disease starts in the fingers

\$47 Impacto BG 650L
Material Grain Leather - Air Bubble Bladder in the Palm - Fingers and Thumb - Driver Style Elasticized Cuff - Standards EN420 - ANSI S3.40-2002 - EN ISO 10819:1996

\$34 Chase/Decade Model 52105 (Large)
Independently tested and proven to reduce conduction of harmful vibration frequencies. Hook and loop closure keeps debris out of glove. Flexible goatskin leather palm.



\$17.21 Youngstown Glove 03-3110-80-L Carpenter Plus Performance Glove Large, Gray

Remember disease starts in the fingers

What's on the web? Some results of a recent search for "anti-vibration" gloves

Photos above show several products currently marketed as "Anti-Vibration" gloves.

The information in the diagram above was obtained from websites of the following vendors:

Vendor #1: Impacto Model BG 650L: Meets ANSI S2.73/ISO 10819 performance criteria.
(<http://www.impacto.ca/catalog.php?item=1213> website accessed on 1/16/2012)

Vendor #2: Chase Ergonomics Model 52105 XX-Large: Meets ANSI S2.73/ISO 10819 performance criteria
(<http://www.chaseergo.com/LEVEL%205%20FACT%20SHEETS/LEVEL%205%20FACT%20SHEETS/L5-DECADE%20INDUSTRIAL/L5-di-HANDProtection/L5-di-52102.pdf> website accessed on 1/16/2012)

Vendor #3: Superior Gove Model VIBGHFV: Partial finger glove- cannot meet ANSI S2.73/ISO 10819 criteria for certification as anti-vibration glove due to lack of full finger protection. However, it is marketed as an "anti-vibration" glove.
(http://www.superiorglove.com/VibrationDampening_Gloves_P501.html accessed on 1/16/2012)

Vendor #4: Youngstown Glove 03-3110-80-L: Partial finger glove- cannot meet ANSI S2.73/ISO 10819 criteria for certification as anti-vibration glove due to lack of full finger protection. However, it is marketed as an "anti-vibration" glove.
(<http://www.amazon.com/Youngstown-Glove-03-3110-80-L-Carpenter-Performance/dp/B0000950R3> accessed on 1/16/2012)

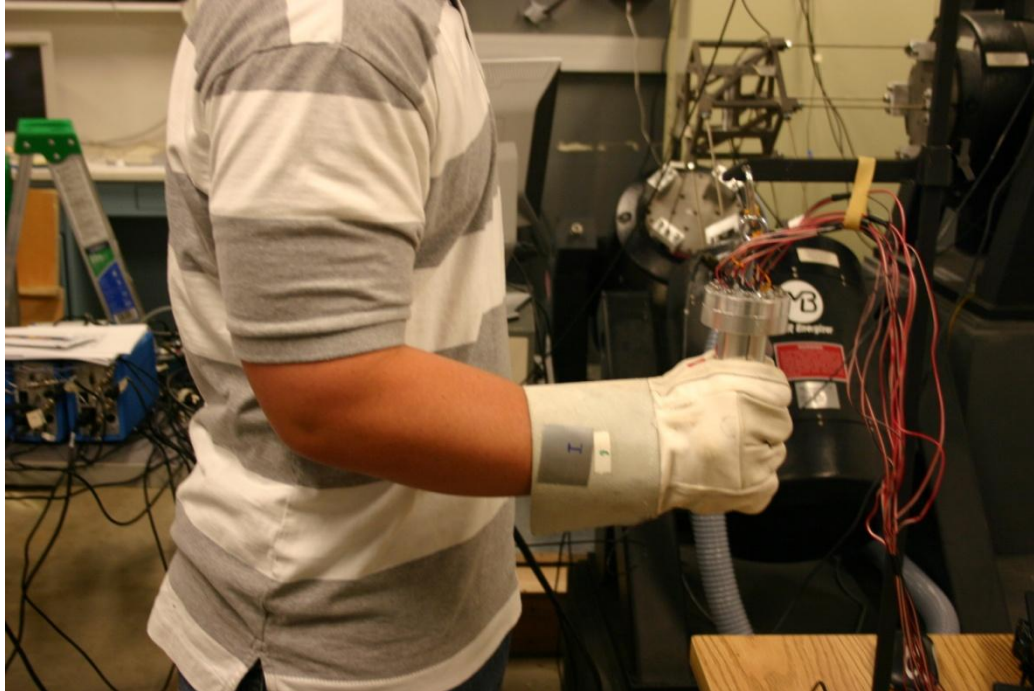
Subsequently, the U.S. Naval Supply Systems Command/Navy Clothing and Textile Research Facility (NAVSUP/NCTRF) entered into an agreement with the NIOSH Physical Effects Research Team, Engineering and Control Technology Branch, Health Effects Laboratory Division to study hand-transmitted vibration exposure which resulted in an overview of available glove effectiveness.

As a part of the agreement, NIOSH completed a laboratory study which:

- Identified effective commercially-available gloves which can reduce hand-transmitted vibration exposure during the use of vibratory tools.
- Measured the vibration transmissibility functions of eight glove models relative to different frequencies to identify the gloves that meet the testing criteria of the ISO Standard 10819 (1996).
- Measured the magnitude of the reduction in grip strength associated with the use of the test gloves.
- Communicated these results to government procurement contacts.



A NIOSH researcher tests the vibration attenuation (reduction) provided by protective gloves. An accelerometer (vibration measuring device) underneath his glove measures vibration transmitted to his hand and allows evaluation of the level of vibration reduction provided by the glove being tested.



A NIOSH researcher measures the grip strength of his hand wearing a test glove as compared with his ungloved hand's grip strength. Excessive reduction in grip strength suggests that the user needs to exert more force when wearing the glove, may fatigue more rapidly and may increase the coupling between hand and tool, thus increasing the transmitted vibration exposure.

Study Findings

The NIOSH study confirmed that the vibration isolation effectiveness of the gloves was frequency-specific. While the gloves did not significantly reduce vibrations at low frequencies (those below 25 Hz (cycles per second)), they did provide some reduction of the vibration transmitted to the palm of the hand. Glove effectiveness was generally better at higher vibration frequencies. Effectiveness also varied significantly among the glove models, primarily depending on the isolation materials of the gloves. The tested gloves, were ranked in terms of vibration attenuation and grip strength reduction. This allowed users to identify the most effective models.

This study also helped lead to substantial improvements of the standardized method for testing AV gloves, which have been adopted in the revised version of the ISO 10819 (2010) standard.

The study found that anti-vibration gloves greatly reduced grip strength by more than 33% compared with the bare-hand grip strength. A reduction in grip strength requires a more forceful tool grip which has been associated with an increased potential for carpal tunnel syndrome and other disorders. As a result of the increased force required to grip a tool while wearing AV gloves it remains unknown to what degree AV gloves will help reduce HAVS, even after vibration attenuation is taken into account. This increases the necessity for workers to be involved in the selection of gloves that fit well and are comfortable.

Study Recommendations

- The use of AV gloves was not recommended when using low frequency (below 25 Hz) vibration- generating tools such as sand rammers, tampers, and vibratory forks, used in operations such as foundries. Less costly “ordinary” non-vibration gloves were equally effective in providing improved grip and didn’t have the “extra” thickness of AV gloves.
- Do not require workers to use AV gloves when finger dexterity is essential to a task.
- Make AV gloves available to workers but do not force anyone to wear them if he/she does not want to for the following reasons:
 - Regular working gloves can also keep the hand warm and provide some other protections to the hands.
 - Because tools vary in the frequency of vibration they produce and gloves vary in their vibration reduction at different frequencies and other characteristics (such as thickness, flexibility, range of available sizes), workers need to play a key role in determining what feels most comfortable and suitable for them.
- The transmissibility functions (vibration reduction at different frequencies) measured in this study may help facilitate decisions for selecting gloves for use with specific tools.

Simple Guidance for Users

- Ask if gloves are “certified” to meet ANSI 2.73/ISO 10819 standards.
- Gloves used to reduce vibration must completely cover the fingers (vibration problems start in the fingers).
- Gloves must have been tested to measure the level of vibration reduction they provide.

Guidance for users of AV gloves, posted on the DOD Ergonomics website is available at;
<http://www.ergoworkinggroup.org/ewgweb/SubPages/ProgramTools/Publications/2005Pubs/98DODEWGNews.pdf>

Supplemental information on HAVS may be found at:

The Naval Safety Center website:

http://www.public.navy.mil/navsafecen/Documents/acquisition/HAWS_Fact_Sheet.pdf

National Institute for Occupational Safety and Health website:

<http://www.cdc.gov/niosh/topics/ergonomics/#vib> and

<http://wwwn.cdc.gov/niosh-sound-vibration/Default.aspx>